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IS 12424 (1988): Hot box resin for use in foundries [MTD 14: Foundry]

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(Reaffirmed 2003)

Indian Standard

SPECIFICATION FOR
HOT BOX RESIN FOR USE IN FOUNDRIES

1. Scope — This standard prescribes the requirements and methods of tests for hot box resin for use in foundries.

2. Supply of Material — General requirements relating to the supply of hot box resin shall be as specified in IS : 1387-1967 'General requirements relating to the supply of metallurgical meterials (*first revision*)'.

3. Definition — For the purpose of this standard, the following definition shall apply.

3.1 *Batch* — A quality of material so designated by the supplier which is substantially uniform.

4. *Types* — Hot box resins have been classified in the following four types according to their base material and properties:

a) *Type* 1 — Phenol/urea formaldehyde resins,
b) *Type* 2 — Phenol/formaldehyde resins,
c) *Type* 3 — Urea formaldehyde/furfuryl alcohol resins or furan/urea base resins, and
d) *Type* 4 — Phenolic/furfuryl alcohol base resins or furan phenol base resin.

5. Requirements of Physical Characteristics — The colour of the resin shall conform to the colour making standards as agreed to between the purchaser and the supplier when tested by the method prescribed in Appendix A. The test results on resin system when tested by the methods prescribed in Appendix B to G given in Table 1 shall be within the limits agreed to between the purchaser and the supplier.

6. Requirements of Mechanical Characteristics — The requirements of mechanical characteristics or functional test properties for evaluating quality of hot box resin when tested (under relative humidity 50 to 70 percent) according to the procedure specified in Appendix H shall be as given in Table 2.

7. Storage Life — The material, when stored in the original unopened container for six weeks (eight weeks for 1 degree higher ambient temperature) under the conditions specified by the manufacturer, shall not show any deterioration with respect to the properties specified in this standard.

8. Instructions for Use — Manufacturers of resin or resin systems shall provide the following information:

a) *Method of Use* — The proportion and the type of resin and curing agent together with the method of mixing and curing;
b) *Safety Precautions* — Details of safety precautions to be taken during storing, handling, mixing and curing the resin, and curing agents; and
c) *Storage Conditions* — Details of recommended storage conditions.

9. Sampling — In view of the possibility of stratification of material within the container, it is essential that the contents of any container selected for sampling for test purposes shall be mixed thoroughly before the sample is taken. One sample representing each manufacturing batch shall be taken.

9.1 The specific gravity, viscosity and gel time at room temperature shall be determined on each batch of resin or resin system as appropriate.

10. Criteria for Conformity — The resin system shall be deemed to conform to this standard if they comply with all the requirements mentioned above.

Foundry Sectional Committee, SMDC 17 [Ref : Doc : SMDC 17 (2932)]

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BUREAU OF INDIAN STANDARDS
MANAK BAHAVAN, 9 BAHADUR SHAH ZAFAR MARG
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TABLE 1 REQUIREMENTS OF PHYSICAL CHARACTERISTICS OF HOT BOX RESINS AND PERMISSIBLE DEVIATIONS

(*Clause* 5)

Sl No.	Characteristic	PF/UF Requirements	Phenol Formaldehyde	UF/FA	PF/FA	Methods of Test
i)	Relative density at 30°C	1·24 ± 0·02	1·15-1·25	1·24 ± 0·02	1·22 ± 0·02	Appendix B
ii)	Viscosity at room temperature in seconds (Ford cup 4) at 30°C	60-120	80-150 (for break of flow)	80-120	120-150	Appendix C
iii)	Total solids, percent by mass	63 ± 2	64 ± 2	60 ± 2	60 ± 2	Appendix D
iv)	*p*H	6·5-7·5	6·5-7·5	6·5-7·5	6·5-7·5	Appendix E
v)	Free formaldehyde, percent	6·0, *Max*	6·0, *Max*	6·0, *Max*	6·0, *Max*	Appendix F
vi)	Nitrogen content in resin, percent	6·0, *Max*	Nil	12, *Max*	Nil	Appendix G
vii)	Metal to be cast	Iron	Steel, iron	Non-ferrous, iron	Iron, steel	—

TABLE 2 REQUIREMENTS OF MECHANICAL CHARACTERISTICS OF HOT BOX RESINS

(*Clause* 6)

Sl No.	Characteristic	PF/UF	Phenol Formaldehyde	UF/FA	PF/FA
i)	Hot tensile strength, MPa, *Min*:				
	a) Curing temperature 250°C for 60-120 seconds on 25 mm thick blown specimen	70, *Min* (cured at 250°C for 120s)	65 (cured at 250°C for 120s)	80 (cured at 250°C for 60s)	65 (cured at 250°C for 120s)
ii)	Cold tensile strength, MPa, *Min*				
	a) Same as in i(a), but 24 h, after stripping the specimen from core box (kept in desiccator)	250	200	220	300
iii)	Scratch hardness, *Min*	85	85	85	85
iv)	Total gas evolution at 1 000°C and scratching time of 2·5, *Min*, (cm^3/g)	25	22	22	22

Note — 1 kgf/cm^2 = 10 MPa.

11. Packing and Marking — The material shall be supplied in packages as agreed to between the purchaser and the supplier. The following information shall be indicated on each packing:

a) Name and type of the material;

b) Manufacturer's name or trade-mark, if any;

c) Batch No; and

d) Date of manufacture and expiry date.

11.1 *Standard Marking* — Details available with the Bureau of Indian Standards.

APPENDIX A

(*Clause* 5)

DETERMINATION OF COLOUR

A-1. Outline of the Method — The colour of the prepared test solution is compared against standard colour solution of platinum salts.

A-2. Reagents

A-2.1 *Chloroplatinic Acid* — Dissolve 1·0 g of platinum in a small quantity of *aqua regia* by heating in a water bath. When the material is dissolved, evaporate the solution to dryness. Add 4 ml of hydrochloric acid (rd 1·18) and again evaporate to dryness. Repeat this operation twice. Alternatively, take 2·49 g of potassium chloroplatinate crystals (k_2 Pt Cl_6) which corresponds to 1 g of platinum.

A-2.2 *Cobaltous Chloride Crystals* ($Cocl_2$. 6 H_2O)

A-2.2.1 Dissolve 2 g of cobaltous chloride in 200 ml concentrated hydrochloric acid (rd 1·18). Add either chloroplatinic acid or 2·49 g of potassium chloroplatinate and warm, if necessary, to obtain a clear solution. Cool and pour into a 2-litre measuring flask and dilute with water to the mark. This solution has a colour of 500 Hazen units. From this solution, prepare a series of permanent colour standards having a range of 50 to 300 Hazen units. For this purpose, for each 10 units, pipette 5·0 ml of the platinum solution into a 250 ml measuring flask and dilute with water to the mark. Pour each standard solution into a clear colourless stoppered bottle. Use the same type of bottle for each standard solution. Check these standard solutions at intervals against freshly prepared standard solution.

A-3. Procedure — Siphon about 250 ml of the resin into a dry bottle of the same type as that used for the storage of colour standards. Select the standard solution which most nearly matches the sample. Pour the sample into a 50 ml Nessler tube until its depth reaches the graduation mark. Pour the colour standard solution into the other Nessler tube until the levels are equal. Compare the colour of the sample with that of the standard by looking down the tubes against a white background, taking care to avoid illumination from the sides. Repeat with other colour standards, if necessary. Record the value of the colour to the nearest 10 units for colours up to 100 units, to the nearest 25 units for colours between 100 and 250 units, and to the nearest 50 units for deeper colours.

If the colour of the sample is of the order of 300 units or more, dilute suitably with a colourless solvent, before attempting to make a comparison.

APPENDIX B

(*Clause* 5 and *Table* 1)

METHOD FOR DETERMINATION OF RELATIVE DENSITY

B-1. Outline of the Method — The relative density may be determined with a standard hydrometer or with a relative density bottle or a pyknometer. The relative density bottle or pyknometer method shall be adopted as a referee method in case of dispute. The temperature at which the relative density is measured shall be reported.

B-2. Procedure

B-2.1 *Hydrometer Method* — Pour the material to be tested into a clean jar without splashing so as to avoid the formation of air bubbles. The diameter of the jar shall be at least 2·5 cm greater than the diameter of the hydrometer to be used therein and the hydrometer shall not touch the sides of the jar. If air bubbles are formed, remove them after they have collected on the surface by touching them with a piece of clean blotting paper or filter paper. Keep the jar in a vertical position in a place free from air currents and in a bath maintained at specified temperature. Lower the hydrometer gently into the sample, the unimmersed portion of the stem being kept dry as any unnecessary liquid on stem changes the effective weight of the instrument and affects the reading obtained. Allow sufficient time for the hydrometer to become completaly stationary and for all air bubbles to come to surface. Read the point of the hydrometer scale to which it rises with the eye placed at the surface of the liquid.

Note — The use of the hydrometer method is not recommended for materials of high viscosity.

APPENDIX C

(*Clause* 5 and *Table* 1)

METHOD FOR DETERMINATION OF VISCOSITY BY FORD CUP 4

C-1. Apparatus — The following apparatus shall be required for determination of viscosity by Ford Cup 4 at 30°C.

a) Ford cup viscometer No. 4 with stand,

b) Stop watch, and

c) Polythene beaker of capacity 250 ml.

C-2. Procedure — Fill up the Ford cup with representative sample of hot box resin up to the brim by closing the orifice with index finger at the bottom. Start the stop watch at the time of withdrawing index finger from the aperture till the flow is stopped/arrested. The time is noted for the complete liquid to pass through the aperture which is taken as the viscosity in seconds at room temperature. Care must be taken to ensure that the viscometer is kept in level in the table and the cup used is clean and dry.

APPENDIX D

(*Clause* 5 and *Table* 1)

METHOD FOR DETERMINATION OF TOTAL SOLIDS

D-1. Procedure — Weigh 0·7-0·8 g of hot box resin in pure aluminium dish and add 5 ml of benzene solvent and keep it on the hot plate at 150°C for 15 minutes. It is cooled in a desiccator for 1-2 h, and reweighed, and the weight of the solids is calculated in percentage

APPENDIX E

(*Clause* 5 and *Table* 1)

METHOD FOR DETERMINATION OF *p*H VALUE

E-1. Procedure — Dip *p*H electrode in representative resin liquid and read the *p*H on the scale of a *p*H meter (previously calibrated).

APPENDIX F

(*Clause* 5 and *Table* 1)

METHOD FOR DETERMINATION OF FREE FORMALDEHYDE

F-1. Outline of the Method — This method covers the determination of percent free formaldehyde in foundry resins. The free formaldehyde reacts with sodium sulphite and sodium hydroxide formed is titrated with standard acid The reaction is carried out at low temperature to prevent the decomposition of methynol urea into formaldehyde and urea. This method is applicable to phenolic, furan and urea formaldehyde resins.

F-2. Apparatus — The following apparatus shall be required for determination of free formaldehyde in hot box resins:

a) Beaker	: 150 ml
b) Ice bath	: Any suitable size
c) Balance	: Sensitivity 0·001 g
d) Graduated cylinder	: 100 ml
e) Magnetic stirrer and teflon bar	
f) *p*H meter	
g) Burette	: 50 ml

F-3. Reagents

a) Methyl alcohol	: AR Grade
b) Sodium sulphite	: Anhydrous AR Grade
c) Concentrated hydrochloric acid (HCl)	: AR Grade

d) Standard 0·1 N HCl

e) 1·0 molar sodium sulphite solution. Dissolve 126 g of anhydrous sodium sulphite in distilled water and dilute to 1 litre. Adjust *p*H to 9·5 with 0·1 N HCl solution.

F-4. Procedure — Cool both methyl alcohol and sodium sulphite solution to 15-20°C. Weigh 0·500 to 0·550 g of sample into a beaker. Hold 25 ml of cold methyl alcohol, add stirring bar and place in stirrer to dissolve the sample. Add 25 ml of cold sodium sulphite solution and immediately immerse *p*H electrodes (*see* Note 1), turn on *p*H meter and start titration with 0·1 N HCl. 0·1 N hydrochloric acid is added with stop-cock wide open until a *p*H of 9·8 is achieved; then the addition is made dropwise until *p*H of 9·6 is reached. Record ml of hydrochloric acid required for the titration.

F-5. Calculation

$$\text{Free formaldehyde, percent} = \frac{A \times N \times 3{\cdot}00}{W}$$

where

A = ml of hydrochloric acid solution required for the titration of sample,
N = normality of hydrochloric acid solution, and
W = grams of sample used.

Note — *p*H electrode should be kept in distilled water after the determination is made. Wash the electrodes with methanol and immerse them again in distilled water before another determination. When the *p*H meter indicates that the predetermined *p*H of the distilled water has been reached, the electrodes have been reconditioned and are ready for use again.

APPENDIX G

(*Clause* 5 and *Table* 1)

NITROGEN CONTENT DETERMINATION

G-1. Procedure — Weigh 0·20-0·28 g of resin in a 400 ml glass beaker and to that, add 5 g of sodium sulphate (anhydrous) and a pinch of selenium metal powder and then add 25 ml of concentrated sulphuric acid to this. Digest on the hot plate till it becomes colourless. Remove and cool. Transfer the contents into a 500 ml kjeldahl flask. Wash the beaker with water and pour the contents carefully. Then add cautiously 150 ml of 40 percent sodium hydroxide until it becomes alkaline to methyl red indicator. Hydrolyze the contents and collect the distillate in a 500-ml beaker containing a measured volume of 1 N sulphuric acid (H_2SO_4). Collect the distillate and titrate with 1 N sodium hydroxide (N_aOH) to yellow end point and calculate the nitrogen percent.

G-2. Calculation

$$\text{Nitrogen, percent} = \frac{(A - B) \times 14 \times 100}{\text{Weight of sample} \times 1\,000}$$

where

A = volume of 1 N H_2SO_4, and
B = volume of 1 N N_aOH.

G-3. Precaution — There should not be any, ammonia (NH_3) jar/bottle near the place of experiment.

APPENDIX H

(*Clause* 6)

METHOD OF TESTING HOT BOX RESIN FOR ITS SUITABILITY IN FOUNDRY USE

H-1. General — It describes a practical method for testing hot box resin samples by the foundry.to determine its suitability for a specific application. This method is to be used for guidance only since the requirements of each foundry vary depending on the type of castings produced.

H-2. Preparation of Standard Hot Box Sand Mixing Procedure

H-2.1 In order to evaluate the quality of hot box resin, a standard sand-resin-catalyst mixture shall be prepared.

H-2.2 *Apparatus* — Laboratory type sand muller/mixer.

H-2.3 *Standard Foundry Sand* — Conforming to IS : 3018-1977 'Standard silica sand for raw meterial testing in foundries', or equivalent shall be used.

H-2.4 *Proportions of Additives*:

a) Sand : 10 kg
b) Hot box resin : 2·5 percent of sand by mass
c) Catalyst : 25 percent of resin by mass.

H-2.5 *Procedure for Mixing* — Charge 10 kg of standard sand. Add 62·5 g catalyst and mull for 2 minutes. Add 250 g of resin and mull for 2 minutes. After the mixing cycle is over, the sand shall be discharged on a suitable pan. The sand mix shall be homogenized and stored in polythene bag in properly closed condition.

H-2.5.1 The procedure may be modified to suit the requirements of individual foundries. In case the laboratory type sand muller is not available, the foundry concerned may use the sand mixer normally used in the shop floor for preparing a trial batch mixture. The quantity mixed will also vary proportionately to suit the size of the sand mixer in the ratio of 4 parts of sand, 0·25 parts of resin and 0·063 parts of catalyst by weight.

H-2.5.2 During mulling, there should not be excess of high irritation fumes and bench life should be minimum one hour at ambient conditions.

H-3. Testing of Standard Sand-Resin-Catalyst Mixture

H-3.1 The sand mixture shall be cured in the form of a tensile specimen and then tested for properties such as hot tensile strength, cold tensile strength, scratch hardness and total gas evolution and nitrogen content. For hot tensile and cold tensile strength, suitable type of standard instrument may be used.

H-3.1.1 *Hot tensile strength (distert GF method)* — The sand mix is blown through a hot box blower with a pressure of 0·05 MPa into a 25 mm tensile specimen core box maintained at 250°C with the help of indicating type of temperature controller. The specimen is cured at this temperature for 60 to 120s and then taken out and immediately within 5 to 10s, pulled to determine the tensile strength using the distert or GF machine, the value is entered in terms of MPa. The test is repeated four times and the average value is reported. Curing time of PF/UF resin and UF/FA resin in 60s and curing time of PF resin and PF/FA resin will be 120s.

H-3.1.2 *Cold tensile strength* — Tensile specimen of 25 mm is blown as previously explained, at 250°C temperature and curing time of 60 to 120s depending on the type of resin. It is taken out and kept free from moisture and pulled after 24 h, the average result of four specimens is noted in terms of MPa and reported.

H-3.1.3 *Scratch hardness* — The cold tensile specimen before breaking is used for this test. The sharp end of the scratch hardness tester is pressed on the specimen and a line is scratched across the specimen. At the same time, the value of the indicator in the scale of the tester is noted. The above value is reported as the scratch hardness value.

H-3.1.4 *Gas content* — The cured broken halves of cold tensile specimen are rubbed against each other and the sand thus collected is used for the test. 2·0 g of sand is weighed in a previously ignited combustion boat. The gas evolution apparatus is kept at 1 000°C temperature and the levelling bottle is placed intact without any leakage. A standard sample is run in duplicate to check the apparatus. Then the sample is placed in the hot zone and the tube is closed with a rubber bunk, simultaneously switching on the stop clock. The gas evolved is noted for 5, 10, 15, 20, 25, 30, 60, 90, 120 and 150s, using the levelling bottle and recorded. From this, the gas content is reported as cc/g.

EXPLANATORY NOTE

The hot box process has become very much popular in recent years in Indian foundries, specially those producing automotive and farm implement castings.

The hot cure process involves the mixing of sand with suitable proportions of resin and catalyst. The resins are usually phenolic and furan base organic compounds which are capable of undergoing polymerization at high temperatures. Catalysts are usually salts, stable for long periods at ambient temperature. The thermal input from heated core-box (230-270°C) release acid from the catalyst which reduced the *p*H of the resin, thereby causing rapid polymerization of resin sand resulting in rapid curing. The major advantage of this process is its speed and dimensional accuracy.

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